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THE SUBMARINE TELEGRAPH SERVICE.

ANY electrician who has been behind the scenes in the submarine telegraph service, that is, the service of the large companies abroad, cannot fail to have remarked the ignorance of the theoretical parts of the sciences upon which their professional duties depend, which prevails, not only amongst the clerks or manipulators of a station, but even amongst the electricians themselves. As a rule, a telegraph clerk does not carry his electrical studies beyond the fingering of his signalling key. He is even unacquainted with the theory and elementary parts of the telegraphic circuit which he operates, how the message travels, and the action of the different apparatus connected up. He relies entirely on the electrician. If his signals become shaky, or cease altogether, if a wire becomes loose or drops off an instrument, he resigns his function and twirls his thumbs until the electrician can be brought to set matters right. Even clerks in charge are too often helpless in the case of broken or lost signals. We have seen a serious delay of several hours take place in the through traffic of a great company, because the clerk in charge was either too timid or too ignorant to investigate into the cause of the stoppage amongst his own apparatus, and the station electrician was at the time off duty, and could not be found. Even the electrician frequently displays a deplorable lack of theoretical knowledge which sooner or later, however well he may perform his routine duties, must militate against himself and his employers when something goes wrong.

The cause of this ignorance is not far to seek. Station life abroad is not at all conducive to habits of study, and unless a sound training has been acquired at home, and habits of study inculcated which will never entirely leave him, the telegraphist, exiled to a foreign station, often in a semi-barbarous country, and under a tropical sun, is not likely to acquire them afterwards. He resigns himself easily to the circumstances around him, only taking care to be efficient in his routine duties, and seldom or never preparing himself for possible calls upon his knowledge and skill where he is, or in a future career elsewhere.

It is a matter for regret that clerks should content themselves with the merely mechanical work of manipulation. We are far from thinking that the more intelligent amongst them are entirely unacquainted with the elements of telegraphy; but we think that such knowledge should be in the possession of all. The clerk may say that it is the electrician's business to know these things, not his. But what should we think of an engine-driver who only knew what stop cocks to turn off and on about his engine, and nothing more, because that was the engineer's duty. We should prize the driver more highly if he knew every part of his engine and all its actions. It would be the engineer's duty still to put the engine to rights, especially when anything serious was wrong, and his knowledge would extend far wider and deeper than the driver's. Similarly in the more refined work of telegraphy, an operator would be more valuable if he also possessed an elementary knowledge of the science and the instruments he used. He might thus be able on occasion to remedy, at least, trifling defects. His knowledge would coalesce with that of the electrican, which would only be more profound, and have a greater range and technicality. The electrican cannot be always at hand, and without encroaching on the electrician's duties, the clerk himself, or at any rate the clerk in charge, might sometimes obviate a considerable delay. And even when the electrican is at hand, he is all the better sometimes for intelligent assistance.

We come now to the question of how and where a proper training is to be got at home. Hitherto the electricans of the companies have mostly been drawn from those of the manipulating staff who had been fortunate enough to see some electrical work on cable-laying and repairing expeditions, or who had been specially taken in hand at the instigation of influential "friends at court." But there is now a growing preference for well educated young gentlemen who have acquired a competent knowledge of the science by lectures and private study at home, and who are also efficient mechanicians. This is a good sign. The electrician's is an important and highly scientific profession, and it has been too much the fashion hitherto to believe that anybody after a few months' practice would be thoroughly competent to carry out any work which an electrician may be called upon to do. We know some construction companies that have paid dearly for a creed of this kind. Just as it was found out by dear experience that only the best materials should enter into the composition of a cable, and searching tests regularly made of all its electrical properties, so it is being discovered that a cable should be in the best possible hands after it is laid. A station electrican's education should with advantage comprise a thorough knowledge of the elementary principles of electricity, mechanics (including dynamics), chemistry and physics; to ensure which mathematics is, of course, necessary. He should

have a knowledge of geometry at least as far as the books of Euclid, and a little conic sections, besides a knowledge of elementary plane trigonometry, and of algebra, as far as quadratic equations. For the solution of the higher formulæ he would require, of course, a knowledge of the differential and integral calculi. But for the mere interpretation and practical application of all the formulæ he will use in testing, the ordinary algebra will suffice. He should know the theory of electrical measurements, of electrical signalling, of the voltaic circuit, and of all instruments used in telegraphy, either directly or indirectly. He should know the qualities of the different kinds of batteries, their construction, mode of action, and maintenance. He ought also to be well versed in the relations of the battery to the rest of the circuit, and how to get the maximum or other proportion of current in a certain circuit. He ought to be able skillfully to make all the usual electrical tests of the cable, and especially to be familiar with a few of the best tests for localising faults, and be also able, if need be, to apply others. In addition to all this he should be a fair hand at the lathe, and be able to make a piece of apparatus if required.

The above information can be got from lectures at the universities, or at the so-called "schools of telegraphy," and by private study. The latter must always be an important element in education, but the former are very necessary as guides and stimulants to private study. They help to save time; and in the experimental sciences, where experiments involving expensive apparatus are necessary, lectures are almost essential. Of the telegraph schools designed to meet these requirements we do not propose to speak; but there can be no doubt that a thoroughly efficient school would be a desideratum — a school well supplied with instruments of all kinds which the students would be allowed to take down, examine, and set up, and providing a complete curriculum of well-appointed lectures by men well versed, both practically and theoretically, in their subjects, as well as opportunities for practical testing. The Eastern Telegraph Company adopts the excellent plan of having a training station of its own. At Porthcurno, we understand, lectures have been given to the young members of the Company's Staff, for some years back. If such lectures at a company's own training station are properly carried out by men, who, in the first place, possess the requisite knowledge, both practical and theoretical, and, in the second place, possess the power of communicating it to others, they cannot fail some time or another, and in a greater or less degree, to repay themselves with interest.

Another equally remarkable feature of the submarine service is the discontent prevalent at the stations amongst the *employés*, and chiefly amongst the underlings. As surely as you find yourself taking a friendly drink at the café — or whatever does duty for a café — with some member of the staff, so surely is some long grievance unfolded. The comparative idleness and isolation of the life no doubt partly accounts for the scandal and grievances one hears there; but there are other causes less imaginary. Sometimes the clerks' quarters are not in a proper condition. Sometimes the superintendent is disliked and distrusted. And when we reflect that a superintendent of a station has it in his power to be, not only very disagreeable personally, but by his reports to mar the fortunes of a clerk or clerk-in-charge, we can better see the force of this state of affairs. A superintendent respected and liked produces harmony in the staff, and exercises a favourable moral influence. Another fruitful source of discontent is to be found in the too powerful rule of interest at headquarters which governs promotion in the service. A timely word by an influential director at the Home Office secures the advance of some outsider or incapable over the heads of deserving and more able servants already in the company. Such a system must inevitably lead to internecine jealousies and injured feelings. The recipient of the favour is generally regarded with disfavour by his colleagues, and the men who consider themselves passed over are disheartened.

We incline to the opinion, that, if some important home official of the company, such as the general superintendent or his special emissary, made, not merely occasional, but regular and periodic visits to all the stations, there would be far more harmony and willing co-operation among the various members of the foreign staff. In some companies this plan is, designedly or undesignedly, carried out, and with good effect. Without it, the headquarters of the company in the city depend for their information as to the state of the quarters and the abilities and good feeling of the staff, on the reports of the superintendent. It is easy to understand how, in such a case, a capable servant may be neglected, or a point of comfort passed over. Nor is this all. Sometimes one superintendent is allowed to give orders to and report upon another who happens to be less favourably situated at the remoter end of the cable. Need we say that in these circumstances, when something goes wrong, the "man at the other end" will never be unduly blamed? A special emissary would, on the other hand, make the headquarters of the company to a great degree independent of these reports. He would be able to see and hear things for himself. He would be able to judge personally of the individual capabilities of the staff, the cleanliness and comfort of the quarters, and in addition to this he would be there to hear whatever complaints the staff had to lay before him.

MICHAEL FARADAY.

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He went on working up to about 1862. Our photograph, by Mr. E. J. Mayall, of Brighton, shows him as he was in 1858, then in his sixty-eighth year. Almost his last labour was an effort to establish a conservation of *force* (not *energy*, the conservation of which was by that time a well-recognised truth), but in this he was unsuccessful. On June 20th, 1862, he gave his last Friday evening lecture at the Royal Institution. For thirty-eight years he had been the life of the place. Week after week his simple eloquence, his apt illustrations, his thorough mastery of his subjects, had set London on fire with something of his own enthusiasm. "Whatever might be the after-thought or the after-pursuit, each hearer for the time shared his zeal and

his delight," is the testimony of one who draws an appreciative picture of the great lecturer. But at last he found his memory failing, and the skill of his hand passing from him, and touchingly and simply he bade his audience farewell. He waited on quietly until August 25th, 1867, when he died in his chair, in his study.

We have said nothing as yet of Faraday's honours. One and one only he ever sought—that of election to the Royal Society; so many others poured in upon him unsolicited that it would be difficult to name one which he did not receive. He was made a D.C.L. of Oxford, an LL.D. of Cambridge, and a Ph.D. of Prague. Dr. Gladstone tells us that "he was decorated with ninety-five titles and marks of merit, including the blue ribbon of science, for in 1844 he was chosen one of the eight foreign associates of the French Academy." He was offered but refused the post of President of the Royal Society.

His various biographers agree closely in the estimates they have given us of the character of Faraday. Indeed no one who reads his numerous letters, and his diary, need be at a loss to form one for himself. The immense amount of work that he did is itself sufficient evidence of his remarkable energy; the Royal Society Catalogue gives a list of 158 papers under his name. He was above all things an experimentalist. If he heard of a new discovery he always repeated the experiment for himself before he would accept it fully. "I was never able to make a fact my own without seeing it," he says: "I could trust a fact, and always cross-examined an assertion." And again: "Without experiment I am nothing." But for all this he was in the highest degree imaginative, as his theory of lines of force, and his speculations as to the nature of matter and of ray-vibrations show — speculations so fine that they will hardly submit to the trammels of language. He early foresaw the doctrine of the conservation of energy, although he misunderstood it in its scientific expression, and almost all his discoveries may be traced to his firmly rooted notion that some sort of interdependence exists between the various forms of physical action. He never began a piece of work without a preconceived idea, but his strong love of truth preserved him from any bias in the interpretation of his results. He was exceedingly cautious in coming to a final conclusion, and perfectly ready, if need be, to acknowledge failure. In stating a fact he would use no terms that seemed to imply an hypothesis, he would rather invent a new name than leave room for any misconception. It is hard to know which to praise most, the insight that foresaw a possible discovery, the experimental skill with which the conception was realised and the fact made sure, or the exquisite simplicity and clearness of the language in which the result was expressed.

To the characteristics of a model philosopher he added the most lovable qualities as a man: genuine, simple, modest, and childlike, he drew all men to him. "He had learned," says Dr. Gladstone, "the difficult art of honouring all men." But he expected that others should treat him as he treated them, and he would brook no suspicion of his honour or indignity to his profession. Always gentle, he could be firm too. Often in private life, but only here and there in his writings, a quiet humour came out, as, for instance, when, describing in his journal the noisy clatter of a French market-place, he adds, "They must be a very thinking race to have so much to say."

But no feature of his character was more marked than his deep religious reverence, which indeed was the mainspring of his everyday life. "His standard of duty was supernatural," says Dr. Bence Jones. His faith never clashed with his science, he kept the two singularly apart, but both were equally real and true to him. He belonged to a small obscure sect called Sandemanians, and ministered actively amongst them for a great part of his life. Besides being distinguished for the simplicity of their creed, members of this body are remarkable for their religious and social isolation from the outside world. One of them, Miss Sarah Barnard, became Faraday's wife, in 1821, and survived him at his death. Long after his marriage he spoke of it as an event which, as a source of honour and happiness, far exceeded all the rest that had happened to him.

"One rule his life was fashioned to fulfil;
That he who tends Truth's shrine, and does the best
Of Science, with a humble, faithful will,
The God of Truth and Knowledge serveth best.

"And from his humbleness, what heights he won!
By slow march of induction, pace on pace,
Scaling the peaks that seemed to strike the sun,
Whence few can look, unblinded, in his face.

"Until he reached the stand which they that win
A bird's-eye glance o'er Nature's realm may throw;
Whence the mind's ken by larger sweep takes in
What seems confusion, looked at from below.

* * * * *

"Yet, living face to face with these great laws,
Great truths, great mysteries, all who saw him near
Knew him for childlike, simple, free from flaws
Of temper, full of love that casts out fear:

"Untired of charity, of cheer serene;
Not caring world's wealth or good word to earn;
Childhood's or manhood's ear content to win;
And still as glad to teach as meek to learn."

Punch, September 7, 1867.

INDIA-RUBBER CONSIDERED IN REFERENCE TO ITS APPLICATION TO TELEGRAPHY.

By THOMAS T. P. BRUCE WARREN,
Analytical Chemist to the India-rubber, Gutta-percha, and Telegraph Works Company, Limited.

(*Continued from page* 149.)

AFTER the failure of the Atlantic Cable of 1857–1858, several india-rubber manufacturers and others directed their attention to the use of india-rubber under different forms for insulating telegraph wires, among whom may be mentioned Hooper, Silver, Siemens, Hall, and Wells, Wray, Radcliffe, and Daft.

Hitherto gutta-percha had enjoyed an undisputed right as the insulating medium for telegraph cores. There can be no question as to the great and rapid improvement which was made in the manufacture of gutta-percha cores at this time, and I cannot help thinking but that the threatened competition which india-rubber appeared to offer helped very materially to improve the quality of gutta-percha covered wires.

So perfect are the appliances and the security of the processes concerned in insulating with gutta-percha, that it is possible to cover several hundred miles without the slightest defect. This, no doubt, is due in a very great measure to the simplicity of the manufacturing operations, and to the fact that the wire can be examined at intermediate stages of its manufacture.

The preliminary treatment of india-rubber is precisely the same as that which is carried out for the ordinary manufacturing purposes; it consists of—

Firstly, the washing process, which separates the soluble matter contained in the india-rubber, and other extraneous substances.

Secondly, the masticating, which reduces it to a form from which sheets, slabs, or tapes can be cut.

Thirdly, the grinding and mixing, by which sulphur and other matters are incorporated with the rubber for vulcanising.

Fourthly, the vulcanising or consolidating process, which causes the coatings to unite so as to form a compact and uniform covering, and to bring about that change in the india-rubber which is termed "vulcanised."

The washing or cleansing process.—India-rubber, unlike gutta-percha, cannot be softened by heat so as to separate the woody matter occasionally found mixed with it; hence the kinds of india-rubber employed for insulating must be as free as possible from those impurities which water itself will not remove. The Para bottle-rubber is therefore well suited for this purpose.

The bottles are first well washed to remove the extraneous matter and dirt adhering to the outside, and then cut open and examined; for it is not by any means an unusual thing to find in a case of Para rubber a few bottles which must be rejected for insulating. This examination of the rubber appears to be more necessary now than was required a few years ago; sometimes, though rarely with Para bottles, a lump of clay or stone is embedded in the rubber.

The rubber when cut into convenient pieces is passed between a pair of corrugated iron rollers, whilst a stream of water is continually playing upon it. The process is continued until the rubber comes away in the form of a sheet with very rough surfaces. It is then transferred to another pair of rollers with finer corrugations: these rollers being closer together, the sheet becomes more attenuated, so that increased facility is given for the removal of any substances which the water can dissolve.

These sheets are then soaked for some time in perfectly clean water, and are afterwards hung up to dry. The rubber when perfectly washed is so free from soluble matter that, if digested in distilled water for some hours, a few drops of a solution of permanganate of potash added to the liquid undergo little or no change of colour. If the washing process has been imperfectly carried out the surface of the rubber becomes more or less covered with mildew after a short time. The effect of this when the rubber is used for insulating is not known; it is considered more prudent, however, to re wash such sheets, or to discard them for insulating.

The matters removed by washing are water, gum, sugar, salts, &c., which are dissolved, and other organic substances, which are mechanically washed out.

Provided that direct sunlight be excluded it appears that washed rubber may be kept for years unaltered, so that this process does not entail any tendency to change or decompose the rubber.

The loss which the india-rubber undergoes in weight by washing varies from 10 to 15 per cent. with the best Para bottles, and reaches as high as 25 per cent. with the Negro-head variety.

Faraday has stated that india-rubber melts at 237° Fahr. It is well known that india-rubber, strictly speaking, does not melt at this temperature; it softens, and does not, on cooling, regain its original firmness, but gradually turns to a viscous, tarry-looking mass. If india-rubber be heated to 212° Fahr. for a short time, or even lower temperature for a longer time, it will present in course of time exactly the same phenomenon. This is the most important fact with which manufacturers of india-rubber insulated wire have had to deal. From this it is obvious that the more impure descriptions of india-rubber which contain impurities incapable of being removed by washing are hopelessly shut out from our consideration.

The drying is effected by moderate steam heat, in rooms from which actinic light is carefully excluded. Whether for the manufacture of telegraph wire, or for the better descriptions of ordinary manufactured india-rubber goods, this process of washing and drying is carefully carried out.

The amount of ash left on the incineration of a sample of dry Para bottle-rubber varies slightly. I find ·13 per cent. with the raw Para; the same washed and dried yields per cent.; the Negro-head well washed and dried yields 1·7 per cent.

Masticating.—The rubber when thoroughly dried is masticated. The masticator consists of a strong cast-iron cylinder or axis fluted in the direction of its length to within a little distance of its ends. This revolves in a closed iron frame or casing, fitting closely to the fluted cylinder at the ends. As the cylinder and its casing are not concentric, it allows the rubber to be carried round with a kneading and crushing action as well. The heat generated in the rubber at the same time softens it and assists the process.

The time required for masticating a block or slab of india-rubber is a point requiring great nicety and judgment. It should be thoroughly and uniformly worked up, which is best shown in its yielding a sheet, when cut, free from air cavities and irregularity of surface.

When masticated and whilst still warm it is forced into moulds and well pressed, until it ceases to yield any further.

Before removal from the moulds it is hardened, in the summer, by means of ice, or by being left in a cool place. It is then ready for cutting up into sheets or slabs.

Necessarily, by the masticating process a very large quantity of air is incorporated with the rubber in the earlier stages of masticating, but which is again partly forced out by the kneading action towards the end of the process. A considerable quantity of atmospheric oxygen is retained by the india-rubber in a state of chemical combination. It becomes much darker in colour, and loses a very great deal of its firmness and strength; a block of rubber over-masticated has a decidedly empyreumatic smell, and yields a very sticky soft

tape or sheet when cut up, but which, nevertheless, is more susceptible to the action of sulphur than a sheet cut from a block which yields a hard and "curly" sheet. The decay in india-rubber covered wires referred to by Professor Abel in his Inaugural address to the Society of Telegraph Engineers, is to my mind more capable of being explained from this fact than by the reasons which have been assigned for it.

Before we proceed further it will be better to consider a few of the properties of india-rubber in its masticated form, for it is in this state that it receives its impetus to change. The investigations of Drs. Miller and Hoffman, have shewn that where india-rubber has indicated a tendency to decompose, a large quantity of oxygen has been found united to the elements of caoutchouc, and the general deduction drawn from this fact is that decomposed india-rubber is simply oxidized caoutchouc.

When masticated india-rubber is digested in pure alcohol, it parts with a considerable quantity of a soft viscid substance, which differs from the generality of resins in being indifferent to the formation of salts with basic substances. It does not harden by exposure to the air, and possesses in a marked degree the peculiar odour of masticated rubber. When the whole of this substance is extracted, the india-rubber is left perfectly white, but by long digestion it suffers another change by becoming quite glutinous and sticky. This is in contradiction to the statement made by all chemical writers on this substance, that alcohol has no effect on caoutchouc, and calls for a re-examination of the action of alcohol on india-rubber, for it is not impossible that raw caoutchouc may be unaltered by long digestion in alcohol; my experiments were made on a tape cut from a sheet of masticated india-rubber.

Now the writer can cite several cases where india-rubber has decomposed, but where no atmospherical influence has been called in play; unfortunately, however, I have not been able to analyse this rubber or to follow the matter up in a way to settle such an important point, and must therefore conclude this portion of the subject by reference to an experiment which I made a few years ago, in which a piece of masticated tape rubber was heated to 237° Far. in an atmosphere of carbonic acid, and then confined in a dark cupboard. In a few days the india-rubber had begun to assume a liquid form, by exposure to the air it dried up into a brittle shiny mass.

The tape was stretched by being lapped round a plain (untinned) copper wire.

Another experiment made at the same time by exposing a strip of the same rubber to ozonized oxygen did not liquidfy or soften, but gradually darkened in colour and became brittle and rotten.

From these facts I conclude that the cause of the liquefaction of india-rubber where the direct access of air is excluded, has not been satisfactorily accounted for. I have several very interesting experiments in hand on this subject, which I hope at a future time to lay before the readers of this Journal, when considering the decay of india-rubber insulated wires.

Masticated india-rubber invariably decomposes more rapidly in contact with copper wire than when the same wire is coated with tin or any other protective metal; but as the same change is perceptible where the wire has been coated with gold, silver, brass, zinc, and lead, it is evidently not a change induced solely by the presence of copper. The decomposition appears almost as rapid where the copper has been coated with gold or platinum.

Masticated india-rubber absorbs water to a greater extent than gutta-percha, but not so much as vulcanised india-rubber (that is simply india-rubber and sulphur heated so as to vulcanise the rubber). India-rubber heated is still more pervious, but when blended with other substances which are non-absorbents of water, such as French chalk, metallic oxides, obtained by roasting or heating the metals or their salts in a current of dry air, silica and plumbago. Lime and similar bodies which form hydrates, simply suck up the water, and on this account cannot be too strongly condemned for incorporating with india-rubber for insulating work.

For the purposes of working india-rubber, foreign matter must of necessity be ground or masticated with it, but a little chemical knowledge is sufficient to show that indifference as to their nature is dangerous practice. Some manufacturers instead of masticating the washed rubber for the production of sheets from which the tapes are cut for lapping round the wire, obtain the sheet form by spreading a solution of india-rubber. I believe this is decidedly preferable, provided the whole of the naphtha is removed, especially if the vulcanising process is carefully carried out.

Great care is taken to ensure the perfect absence of all moisture when the rubber is prepared for masticating, and yet it is again thoroughly soaked with water for cutting into sheets. The sheet is then hung up and dried and carefully stowed away ready for tapes when required. It is then subjected again to the action of water and receives its final drying before being lapped on the wire. Now the washed india-rubber is frequently kept for weeks after being well dried in a dry room, and the longer it is kept the better; but when it is masticated and cut into tapes it is only allowed a few days to hang up before being used. Thus, in one stage of the manufacture, great care is taken to ensure the dryness of the rubber, whilst a subsequent stage entails the sacrifice of this perfect dryness and allows only a few days for the moisture which has necessarily been absorbed to become dissipated again.

The rubber in this state, too, is highly hygroscopic. A few years ago the writer was led to believe that isomerism would only account for some changes which he had noticed in masticated india-rubber. The means at my disposal would not admit of my carrying out this investigation at that time; but, as I am still engaged in examining this matter, I hope at a future time to reopen this very interesting subject.

In a former paper on this subject, I gave some microscopic measurements, by Adriani, on india-rubber films. Some time ago I submitted several specimens of masticated and spread rubber to microscopical examination, and also films of cut sheet from the native bottle rubber; the magnifying power was 240, 430, and 720 diameters, and yet no signs of apertures were visible; by carefully stretching these specimens afterwards, and re-examining, they still presented a perfectly non-porous surface. The approximate determination was, that the pores, if

any existed at all, could not be more than the five-millionth part of an inch in diameter.

Vulcanising.—This process consists in heating mixtures of india-rubber with sulphur to bring about what is known as the vulcanised or "cured" condition. The discovery of the fact that india-rubber could be so effectually prevented from decomposing has secured to us the use of this substance, which otherwise must have been abandoned altogether. The manufacture of india-rubber has through its introduction become a very important branch of industry. Next to hemp and cotton, india-rubber is decidedly the most important product derived from the vegetable kingdom in its useful applications. Vulcanisation well deserves to be mentioned with those important inventions which characterise the present era, yet how few of us know anything of the inventor, even by name.

Like many great inventions, the vulcanisation of india-rubber was not the result of scientific deduction. I do not offer this observation in the least disparagingly to the patient toil and ingenuity of Charles Goodyear, for I really believe that our present chemical knowledge, had it been at Goodyear's command, would not have helped him much, or at least would not have enabled him to predict the result. The fact that india-rubber heated with sulphur could be prevented from decomposing was, in the one sense, a discovery due to accident; the absence of a systematic inquiry into the action of sulphur on india-rubber must not be regarded, however, as a measure of Goodyear's knowledge or idea of what may result from his experiments. In his researches every piece of information respecting india-rubber which was known was carefully considered and examined; metallic oxides, magnesia, lime, and other mineral matters were incorporated with india-rubber, and exposed to heat and cold, so as to test the durability of his compounds. At one time it was thought that the resinous matter contained in the turpentine, which at that time was a solvent largely used in the manufacture, was the cause of decomposition, and other solvents and pigments were tried, but all, in process of time, were found to yield equally disappointing results. Goodyear appears to have put every consideration aside, except what concerned the most cherished object of his life, which was to prevent india-rubber becoming sticky; and in this respect it would be difficult to point to any invention as being more meritoriously the result of determined application and skill.

It would be beyond the province of this paper to discuss the history of this invaluable invention, but a little incident may be mentioned here which reflects no credit on our patent laws.

After the discovery of vulcanising, Goodyear entrusted to a friend, who was in England at the time, the negotiation with an india-rubber manufacturer for the transfer of the patent right for this country, or rather, for the sale of the secret, for it was not patented in England at this time. Goodyear's friend left a few samples with Mr. Thomas Hancock, who, in the meantime, by experimenting on Goodyear's specimens, discovered the secret and secured the same by letters patent. The law is still the same now as in those days, but surely it would be no serious amendment to make, that parties who were negotiating for the purchase of a secret from an inventor should be disbarred from securing the same by a patent. The law of patents is directly opposed to all secrets, and so far we are benefitted by it; but when a man, for the purpose of a transaction, leaves samples of his manufacture to be inspected, it is not equity which ought to give a man the benefit of his shrewdness in such a case, although it may be a sample of very good law.

Amongst the numerous applications which Goodyear himself indicated, telegraph wire is not mentioned. At this we need express no surprise, for telegraphy was as yet but dreamt of; but later, when insulation became a desideratum, Goodyear was the first patentee for vulcanised india-rubber wires. It is not often that a mind of such calibre as Goodyear's is met with, for every succeeding invention in connection with vulcanised india-rubber can be easily traced back as being but a link taken from this man's chain of ideas.

Vulcanisation may be effected by heating india-rubber blended with sulphur, or by heating india-rubber in a medium holding sulphur either in solution or suspension, in which case the india-rubber absorbs or takes up the sulphur. The sulphur bath, which is merely sulphur in a molten state, is sometimes used either by immersing india-rubber in it, or by suspending it in the vapour arising from it. Sometimes sulphur is dissolved, as in coal tar or beeswax; the former will vulcanise a strip of india-rubber suspended in it, the latter only when sulphur is mixed with the rubber. These latter methods are useful for curing or vulcanising joints in telegraph wires. No new medium for curing should be adopted without carefully ascertaining its effect on sulphur or sulphur compounds. In consequence of finding several defective joints in india-rubber cores cured in beeswax, the writer was led to the discovery a few years ago that beeswax was capable of extracting sulphur from mixtures of india-rubber and sulphur, which has since led to the practice of previously saturating the beeswax with sulphur.

Instead of sulphur, sometimes the metallic polysulphides of lead, antimony, or arsenic are employed, in which cases the sulphur necessary to vulcanise exists as precipitated sulphur, from the decomposition of the unstable sulphuret immediately following its formation as with the lead compound, or from the decomposition of the alkaline polysulphides containing the sulphides of arsenic or antimony in solution, in which cases the metallic sulphide and sulphur are precipitated together on the addition of a dilute mineral acid.

Another method of vulcanising, known as the cold curing process, which depends on the facility with which the chlorides of sulphur are decomposed when placed in contact with organic substances, is used only for thin sheets or spread india-rubber goods. I am not aware of its application being tried for any purpose connected with telegraphy, although for curing joints, or any kind of temporary work in places not easily accessible, it would prove very useful.

Previous to Goodyear's invention of vulcanising, sulphur had been employed to prevent or rather to arrest the decomposition of india-rubber. Dr. Leudersdorff, a German chemist who had given considerable attention to india-rubber, attributed the decomposition of this substance to the presence of resinous matters in the turpentine, which I

have previously said was extensively employed as a solvent in the manufacture of india-rubber goods. He recommended the use of sulphur in small quantities. This does not appear to have been much practised. In 1838, Goodyear was informed of this fact by Mr. Nathaniel Hayward, who, following the directions of the German chemist, had been in the habit of rubbing powdered sulphur on such portions of his manufactured articles which had begun to decompose. It is well known that india-rubber incorporated with sulphur will resist the action of the air and sun for a very much longer time than india-rubber not so mixed. The next step was to mix india-rubber and sulphur together. The singular accident which resulted in heating a little of this mixture developed the vulcanising process. It is a common practice now to test the cured condition of a piece of india-rubber by holding it near a fire; and Goodyear was testing in the same way the effect of heat on a portion of his sulphur compound, when by accident it came in contact with the hot stove. Instead of becoming sticky, as might have been expected, he was astonished to find that "it charred like leather without dissolving." He found that it did not harden by exposure to the cold, and the thought then occurred to him to find out the precise temperature and time for heating this mixture. Such is a brief history of the development of this invention of vulcanising.

I am not able to say whether Goodyear manufactured any quantity of insulated wire, but in 1852 Goodyear obtained a patent in this country for this purpose. I shall pass in review Goodyear's patents when examining the inventions of subsequent patentees. The manipulation of the india-rubber, though, perhaps, much improved in its minor details, is pretty much the same as Goodyear's, and the processes of applying it are almost identical.

Other methods of treating india-rubber will be referred to in a future paper. The author discovered a few years ago that iodine, bromine, and chlorine were capable of curing india-rubber; and since this time, the processes have become very largely adopted for sheet rubber and thin manufactured goods. My method of applying this to insulating purposes will form the subject of a separate chapter.

THE TELEPHONE.

No philosophical instrument has excited more interest and wonder than the telephone of Prof. Graham Bell. We had hoped, in the pages of this journal, to have been able before now to have given a detailed description of the various forms in which this instrument has been constructed, and to have been able to announce that public exhibitions of its powers were being given in this country; but as yet, we believe, no specimen of the instrument has arrived from America, though we trust it will not be long before we hear more of it.

The telephone of Prof. Bell differs from all others in that it enables not only the *pitch* of a note but also its *amplitude* to be accurately reproduced, and that by the most simple means.

As is well known, sounds are produced by the vibrations of the tympanum of the ear, the rate at which these vibrations follow one another determining the pitch of the note, and the amplitude of these vibrations the loudness of the same. Combinations of these two elements cause the various sounds which are heard in nature to be produced.

The vibratory movements of the tympanum which produce the sensation of sound are caused by undulations set in motion by bodies external to the ear. Thus, a tuning-fork, by the vibration of its prongs, causes these undulations to enter the ear, and vibrate the tympanum in unison with them. If the vibrations follow one another at the rate—for example, of 720 per second, the note A is sounded; if at a greater rate, a higher; and if at a lower rate, a lower note is obtained.

Now if we take a flexible iron plate, and fix one end firmly on a sound board, and near the other end place the poles of an electro-magnet, by causing intermittent currents to follow one another at a regular rate through the coils of the magnet, we can cause the plate to vibrate in unison with these intermittent currents, through the alternate attractions and cessations of attraction of the plate by the poles of the magnet. By causing these pulses of current to follow one another at different rates, we can produce any note we please. If the pulses are all preserved of equal strength, the loudness of the note will continue the same; but if the battery power be increased or diminished, the amplitude of the vibrations will thereby be increased or diminished, and the loudness of the note will be proportionally altered. We have thus the power of producing the two essential elements for the production of natural sounds.

Suppose we have a membrane tightly stretched like a drum, and produce a sound near it, this membrane will vibrate in unison with this sound, the rate at which it oscillates being directly according to the pitch of the note, and the amplitude of its vibrations being proportional to the loudness of the same. If, now, a contact-point is fixed to the centre of this membrane, and in close proximity to another contact-point, a vibration of the membrane will cause these two points to touch; and if they are in circuit with a battery, and an iron plate and magnet similar to that described, the plate will be attracted; and it is therefore evident that every vibration of the membrane will be followed by a corresponding vibration of the plate. A note then sounded near the membrane will impart its vibrations to the latter; and through the medium of the make and break arrangement will cause the iron plate to give out a corresponding note.

A means is thus found for reproducing at a distance, through the medium of a wire, the pitch of any note. An instrument very similar to this, only differing as regards the receiving part of the apparatus, was the telephone of the late Sir Charles Wheatstone.

But such an arrangement is obviously quite inadequate to alter the amplitude of a note. The distance through which the membrane vibrates can make no difference in the strength of the current traversing the electro-magnet, and no modification of the make and break arrangement can effect this object. Prof. Bell saw this, and abandoning this part of the arrangement has invented an exceedingly simple method of attaining the desired object.

The movement of an armature in front of the poles of an electro-magnet, through which a current from a battery circulates, induces a magneto-current

in these coils, the strength of which current is strictly proportional to the rate at which the armature is moved. Attaching then a small iron armature to the vibratory membrane, and placing in close proximity to it the poles of such an electro-magnet, which was connected to an arrangement similar to the vibrating iron plate, Prof. Bell was enabled to impart to this plate vibrations of the same amplitude as those produced by the membrane, consequently any note sounded near the membrane was exactly reproduced, both in pitch and loudness, on the vibrating plate.

Such is the telephone of Prof. Bell, of which we give figures which require but little explanation.

Fig. 1 shows the transmitting portion of the apparatus containing the membrane, and the electro-magnet.

Fig. 1.

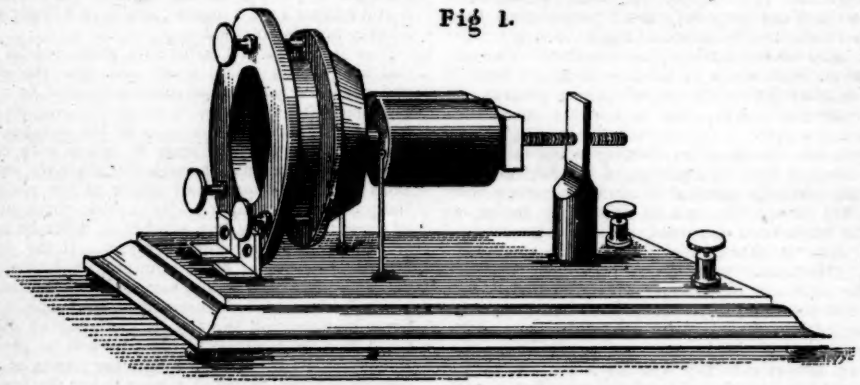

Fig. 2.

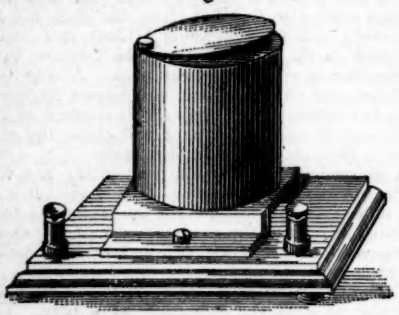

Fig. 2 shows the vibrating iron plate. This latter is of about the thickness of paper, and is placed over the pole of a circular electro-magnet, enclosed in an iron case so as to augment its power.

The only defect which exists in the instrument as at present constructed is its want of power. The apparatus being practically an arrangement worked by the mechanical action of the voice, or other source of sound, necessarily cannot transmit vibrations of as great power as those produced near the instrument, they are actually far weaker. To make the instrument perfect, some kind of relay has yet to be (and will no doubt ere long be) invented, which shall receive the faint vibrations and reproduce them augmented in power. This is the next problem which has to be solved.

We believe Prof. Bell has produced telephones in which the transmitter and receiver are precisely alike, and in which the cores of the electro-magnets are of steel permanently magnetised, the battery thereby being dispensed with.

The telephone of Mr. Varley, about which so much has been heard of lately, in the daily papers, is a totally different instrument to that of Prof. Bell, and indeed cannot be compared with it. It is more of the nature of an electric organ in which only one wire is required for any number of notes so long as only one note at a time is required to be played.

The chief peculiarity of this instrument is the receiving portion of the apparatus.

It consists of an exaggerated tambourine three or four feet in diameter. Within this is placed a condenser formed of four sheets of tinfoil between sheets of insulating material, the sheets being loosely laid together, their area, in the instrument now being exhibited, being about one-half that of the surface of the tambourine. This condenser has its plates parallel to the parchment of the tambourine and in close proximity to it.

If a charge of electricity is thrown on to the plates they attract one another, thereby approaching one another slightly. This produces a movement of the air near them which is communicated to the parchment of the tambourine; consequently, if the charge of electricity is intermittently thrown on the plates and discharged, a continual vibration of the condenser-plates is set up and imparted to the parchment of the tambourine, which emits a note of a pitch proportional to the rapidity with which the charges and discharges succeed one another.

These charges and discharges are produced by connecting the condenser-plates to the two terminals of the secondary wire of an inductorium, and the rate at which the currents are made and broken in the primary wire, consequently deter-

mines the rate at which the tambourine parchment vibrates.

The means by which the makes and breaks are produced in the primary wire is simple enough. There is a contact breaker formed of a tuning fork acted upon by an electro-magnet in the circuit of the primary coil. The two prongs of the fork are placed between the poles of the electro-magnet; when the magnet is excited it attracts the two horns causing them to open and thereby to break a contact in the circuit, and the magnet thus losing its magnetism, allows the prongs of the fork to return to their normal position, thereby renewing the contact and thus a continual vibration of the fork is kept up.

We have only to add that there are several tuning forks each connected to a separate inductorium and that a pianoforte key is connected to each fork, so that any one of them with its inductorium can be put in connection with the condenser in the tambourine, and we have Varley's telephone complete.

Beyond the arrangement for producing the vibrations through the medium of a condenser there is nothing remarkable or ingenious about the instrument, and except to those who are totally unacquainted with electrical science it can hardly prove of interest. We think it would have been as well if Mr. Varley had brought the instrument, such as it is, a little more into good working order before bringing it before the public, but a few failures followed by a success is a very effective mode of conducting an experiment.

CONCLUSIONS ON THE TRANSMISSION OF ELECTRICITY TO THE GROUND THROUGH THE MEDIUM OF TREES.

By M. TH. DU MONCEL.

FIRST.—The trees are all more or less conductors, and their conductability depends upon the quantity of liquid which they contain.

Second.—The roots of a tree play the *rôle* of electrodes, and their efficacy as agents of transmission is proportionate to the conductability of the tree and to its development.

Third.—The value of the resistance of a tree through its leaves, supposing that good contact is only made upon some of them, varies from 2 to 400,000 kilometres of telegraphic wire (in round numbers). That of its trunk, for trees nearly full grown, at a height of 7 or 8 metres, is very rarely higher than 3,000 kilometres, down to the ground, and varies from 2,000 to 7,000 kilometres between small metallic electrodes.

Fourth.—There is not, in consequence, much to be afraid of from contact of telegraph lines with the leaves of a tree, for it is from the insulators covered with smoke employed upon these lines that the resistance becomes low.

Fifth.—The resistance of ordinary buildings being about from sixteen to twenty times greater than that of trees, we can believe that houses surrounded by trees could receive from them a protection against thunder-storms—at least, supposing that the height of trees was not less than the height of the houses; but as it rains in time of storms, and the rain, in covering the trees and houses with a wet film, lessens the differences of conductability which they may possess, the protecting effect of trees can only result in the preponderance of their height.—*Note to the Académie des Sciences.*

ELECTRICITY APPLIED TO COTTON MANUFACTURING.

IN the complicated machinery employed for cotton manufacturing, certain defects exist which cause much trouble to the manufacturer; thus the "spoons" in the drawing-frame very often get out of order, and allow the machinery to run without its proper complement of threads or cotton "sliver"; while the "single" of the intermediate-frame is a more defective point still. In the intermediate-frame the cotton begins to approach that stage of completion toward yarn when a single end being missed in the composition of the yarn spoils the work. Everything depends upon the reliableness and care of the workman to pull off the spoiled work. This is not always done, and it is this defect which led to the application of thought on the part of Mr. Bullough and Mr. Smalley, his commercial traveller, which has resulted in the application of electricity to cotton manufacturing machinery, and for which a prize was given at the American Centennial Exhibition.

Its employment on a large scale is at the Victoria Cotton Spinning and Manufacturing Company, Limited, Rishton, where the machinery is in operation. In the cardmaster's cabin is fixed a small magneto-electro machine, from which electricity is generated by a miniature coil of insulated copper wire revolving in the sphere of six or eight permanent magnets. Attached to the two poles of this source of electricity are two copper wires, conveying one positive and the other negative electricity to the carding engine, drawing, or immediate-frame to be operated upon. At the end of each machine is a small but powerful electro-magnet, which is the direct medium for obtaining the stopping motion. For the back-stop motion of the drawing-frame a long bottom roller is used, and a number of top rollers—one to every two threads or "slivers." Of these rollers the bottom one is connected with the wire from one pole of the magneto-electric machine, and the top rollers with the wire from the other pole; but the thickness of the thread or sliver (which is a non-conductor of electricity) keeps the two apart till a breakage occurs, when the top roller comes in contact with the bottom roller; and the circuit being completed, an electric current is established, which current charges and gives to the electro-magnet an attractive power (which it does not possess while the cotton is between the two rollers) to pull the knocker-off into action, and instantly the machine stops. By similar arrangements to the above the machine also stops when the thread or sliver breaks in front, when the fluted or top rollers lap, and when a can is full. Thus, in the drawing-frame there are four points at which the electric stop-motion acts, and one great feature in the invention is that the workman cannot start the machine until he has "picked up" and put all the threads in working order. This is a great improvement on the existing "spoon"-stop motions, which are not so quick in action, and the application

of the invention to this frame has been successfully accomplished, and is already at work at Messrs. Hindle & Co.'s mill, Clayton-le-Moors, and Mr. B. Walmsley's, Accrington. The application of the motion to this machine is so arranged that it instantly stops when a thread or bobbin is broken in the creel, thus preventing "single." The principle has been also applied to the carding engine, which ceases working when the sliver or web is broken, or the can under the coiler is full. The machines thus act as a check upon the workman, who must make perfect work if he wants them to run at all. Already the new principle is being extensively adopted by manufacturers in different parts of the country, and the first new mill which will have all the drawing-frames and intermediate-frames fitted up with the electric stop-motion will be that of the Lostock Hall Spinning Company, near Preston, the contract for which is now in hand.

Notes.

THE Prussian Government has ordered Berlin to be connected with Hamburg by a subterranean telegraph, in order to avoid perturbations during thunderstorms, which have been very frequent this spring. Similar measures will be adopted for other large towns in Germany.

THE electrolytic deposit of iron on copper possesses a hardness equal to steel. The salt generally employed for producing the deposit is double sulphate of iron and ammonia. The following solution given in the *Chemisches Centralblatt* seems to be more advantageous for this operation: "Dissolve 155 grains of ferrocyanide of potassium and ½ oz. of salt of seignette in 7 oz. of distilled water, and add to it 45 grains of ferric-sulphate, dissolved in 1½ oz. of water; a precipitate of Prussian blue is thus produced. Add then, drop by drop, whilst stirring, caustic soda, until the precipitate is re-dissolved. A limpid yellowish solution is thus formed, which is used as the bath for steeling the copper.

EXHIBITIONS of Varley's telephone take place in the Queen's Theatre and the Canterbury Hall, wires being laid between those two places for the purpose.

IN Prof. Bell's telephone a plate of sheet iron is made to vibrate by means of the electrical current, something after the manner of the skin of a drum-head. In a recent improvement by Mr. G. B. Havens, Louisville, Kentucky, the electrical wires are wrapped around a common tin fruit can. By means of tin cans at each end, sounds, it is said, were sent over 92 miles of wire, and included several pieces of music.

THE *Cape Times* says:—"A rare treat was afforded to the large and fashionable audience assembled in the Public Library yesterday afternoon (June 15th) to hear Mr. Sivewright's lecture on Telegraphy, delivered in connection with the University. His Excellency the Governor presided. We have seldom listened to a more interesting lecture anywhere, and it is quite a new feature at the Cape, and one which cannot be repeated too often. Indeed, we may regard yesterday's lecture as the first of, we hope, a long series, for which we shall be indebted to the influence of Sir Bartle Frere. The first has been a most unqualified success. A crowded hall, an accomplished lecturer, and a gratified audience. It is impossible for us to give even an outline of the lecture. In print it would lose its charm, no matter how faithfully reported. We should miss the grace of the delivery, the maps and electrical instruments by which the lecturer exemplified his argument. The only way to appreciate such lectures is to attend them, and to report them is to rob them of their value. Mr. Sivewright is a lecturer of no mean order. He has a pleasant address, his voice is rich and clear, and language falls in easily with his thoughts. A subject which in the hands of many lecturers would have been a wearisome discourse was fully and clearly explained in a lecture which was listened to with lively interest from beginning to end. At no time did the interest flag, and the instructive and amusing were most happily blended. At the conclusion of the lecture, Sir Bartle Frere proposed a vote of thanks to the lecturer, saying that at other times and in other places he had heard the same subject discussed, but never before with the same interest and instruction, and His Excellency felt quite sure that he was expressing the wish of those present when he threw out the hope that Mr. Sivewright would be induced to repeat the lecture at some future time. Sir Bartle at the same time expressed the thanks of all present to the Committee for the very pleasant afternoon which they had provided, the success of which should lead them to the countenance of similar lectures. Mr. Sivewright, in thanking His Excellency, indulged in the hope that men of other professions would also give up an hour occasionally to explain their work, and he should only be too glad to address them, not only once, but many times if they desired it.

THE Channel Islands Cable between Dartmouth and Guernsey has been repaired.

A DIRECT cable communication is to be formed between Sweden and Russia, the stations being Grisslehamm and Aland.

AT Ocean View, during a recent thunderstorm, 34 telegraph poles were struck by lightning in a distance of a mile and a half. Some were shivered to pieces, while the injury to others was scarcely perceptible.—*American Journal of the Telegraph.*

BEFORE she leaves Chatham for the Mediterranean the Temeraire is to be supplied with two powerful electric lights, similar to those fitted on board the Alexandra flagship.

ON Saturday, the 7th inst., H.R.H. the Prince of Wales, as President of the Society of Arts, presented to Sir George B. Airey the Albert medal, awarded to him by the Council "for eminent services rendered to commerce by his researches in nautical astronomy and in magnetism, and by his improvements in the application of the mariner's compass to the navigation of iron ships.

M. HERVÉ MANJOU has invented an ingenious electrical registering thermometer, a description of which is given in *La Nature.*

THE Emperor William has sent the following message from Gastein to the Postmaster-General of Germany on the occasion of completing the underground wire between Berlin and Mayence :—"My hearty congratulations to the finishing and successful working of the underground line between Berlin and Mayence. I thank you and all the others assembled for your kind wishes."

IT is announced by the Eastern Telegraph Company (Limited) that the Extension Company's Penang-Singapore cable is now in order, thus restoring direct telegraphic communication with Singapore, China, Java, Australia, and New Zealand, *via* Falmouth.

City Notes.

Old Broad Street, July 30, 1877.

As the meeting of the Globe Telegraph and Trust Company is taking place while we are at press, we shall of necessity postpone what comments we have to make on it until our next number. But the report of the directors for the year ending July 18 is before us, and respecting that interesting document we intend to hazard two or three remarks, even though we can in fancy see Messrs. Bircham & Co. standing at our elbow. In spite of Mr. Pender's desperate exertions, and notwithstanding the practical completion of his precious amalgamation scheme, the report reveals the damning fact that the shareholders of the Globe Company will have to be content with a reduced dividend. We once observed, and Messrs. Bircham were kind enough to pardon that observation, that the transactions of the Globe Company appeared to us to be "one of those things that no fellow can make out." But we cheerfully confess that there is one portion of the report before us which he who runs may read. Every fellow understands what is meant by a reduction of dividend. Now let us see how it is that in the face of Mr. Pender's successes elsewhere he has managed things so badly for the Globe Trust. We find, then that, according to the report, "the reduction of dividend on the ordinary shares has arisen from the fact that the Anglo-American Telegraph Company have paid, during the financial year ending 18th July instant, only 3½ per cent. on their ordinary stock, as against 5 per cent. for the preceding year." So it is upon the Anglo Company that the wrath of the Globe shareholders must fall. We have more than a dim recollection of hinting that the stake of the Globe in the Anglo Company was somewhat heavy. We notice, too, that the holding is now rather less than it was at that period, and so far the shareholders of the Globe may be thankful. But it has evidently been difficult to get rid of Anglos, and the Globe Company, in lieu of more than one-third of the entire sum it has invested, holds Anglo shares. We hasten, however, to admit that we are probably pessimists. The immense interest the Globe shareholders have in the Anglo Company may yet be the good ship that will bring them nuggets of gold. It may really have been sheer folly on the part of the directors to let a hundred thousand pounds worth of Anglo shares leave their possession. For, of course, the simple reason why there was a reduction in the Anglo dividend was, as we fancy we have heard before, on account of "the hostile relations between that company and the Direct United States Cable Company, and"—as a natural sequence—"the lowering of the tariff from 3s. per word to the unremunerative rate of 1s. per word." Seeing we have always averred it to be our conviction that the temporary success or collapse of the Globe Company mainly depended upon the prosperity or adversity of the Anglo Company, we were quite prepared for the following paragraph: "An arrangement having now been made between the two companies for a division of receipts on equitable terms, there is every reason to believe that the returns of both companies will be more satisfactory for the future, to the manifest advantage of this company." But how will it be when the time comes, as come it must, for the two companies, influenced by fear of losing everything, to lower their tariff, possibly even to the shilling, certainly to the two shilling, rate? When, in other words, the disastrous consequences of amalgamation shall have actually overtaken them, what then will remain to be said about "satisfactory returns"? One thing is in truth, open to the directors of the Globe Company. If there is not a genuine demand for Anglos there may be a forced one; and if the Globe directors can only manage to reduce their holding of Anglos to a minimum before a rival cable company plays havoc with the receipts of the amalgamated companies, they may do something towards saving themselves. But they are leaning upon a tender reed indeed if they suppose that their Anglo shares can be sold as easily as they were bought. A nether millstone has been securely fastened round the necks of the unfortunate shareholders. We say *a* nether millstone, but we think it will not be an impossible task for us to show on a future occasion that we are entitled to choose the plural number. Meanwhile, we suppose, Mr. Pender is returning thanks for his re-election as chairman, and congratulating the shareholders on their splendid prospects. Happy Pender! Well have you deserved your yachting cruise this year!

The Secretary of the Direct Company courteously

informs us that "At an extraordinary general meeting of the Company held at the City Terminus Hotel on the 13th inst., the resolutions of the Board were carried by an overwhelming majority." We are obliged to Mr. Clarke for his politeness; but the tenor of his communication, even to the "overwhelming majority," was known beforehand. We are pleased to see that at least one of our daily contemporaries agrees with us that the shareholders consenting to the amalgamation should now be permitted "to retain all the advantages to be derived from their persistent efforts to make transatlantic telegraphy a monopoly." It is literally correct that all dissenting shareholders can do is to claim the full value in cash for their holding. We infer they will do it to a man.

We have duly received the Report of the Directors of the Anglo-American Company which, together with the proceedings at the meeting next Friday, we shall refer to in our next issue. Meanwhile we notice that the quarterly dividend is at the rate of 4 per cent. per annum; that notwithstanding the increase in the tariff, the traffic receipts for the six months in 1877 compare unfavourably with the return in 1876; and that somewhat to our surprise, the report contains no ecstatic outburst respecting the joint purse agreement. We shall probably hear more of that at the meeting.

We do not affect to publish news, and if we did the statement that "the half-yearly interest in the A and B debentures of the Western and Brazilian Telegraph Company, due August 1st, will be paid on or after that date at the offices of the Company," would be stale. But it is something to know that the Western and Brazilian Company is not going to give in without a struggle. From the paragraphs which have recently appeared in several newspapers, we could almost imagine that the Wizard of Tokenhouse Yard had undertaken the redemption of the Company. We shall scan the August circular with curiosity.

The proceedings at the half-yearly meeting of the Telegraph Construction and Maintenance Company do not call for lengthened comment. Sir D. Gooch gave an interesting and fairly satisfactory account of the prospects of the Company. We presume the five hundred and fifteen knots of new cable to be laid for the Western and Brazilian Company will be paid for entirely in cash. We do not quite understand what the chairman meant when he said "He did not know that there was any great liability hanging over the Company." If there be such a liability he ought to know; if not, he should have given a more peremptory denial to the insinuation. We cordially endorse Sir D. Gooch's opinion that it is good policy for a company like the Telegraph Construction to have plenty of cash in hand, providing always the directors are aware of the circumstance.

The expected increase in the Brighton dividend is an actuality, although it is only ¼ per cent. But ¼ per cent. is, under the circumstances, extremely satisfactory, especially considering that £4,500 more than last half-year has been added to the balance carried forward. The daring attempt made by some scoundrel to deceive the Stock Exchange by a false statement of dividend continues to be a mystery. We greatly regret that he has not been brought to justice; but we question if the Brighton Company have made sufficiently vigorous efforts to discover him. By some means or other the possibility of such a fraud ought in future to be rendered impossible.

Although the dividend of the South-Eastern is less than last half year, it will, on reflection, be obvious to most people that the position and prospects of the Company are all that can be desired. In these days caution is rather a rare virtue, and the South-Eastern Board, in paying 3½ per cent. when they might have screwed out 3¾ per cent., have manifested courage which might advantageously be emulated.

The Chatham and Dover Preference dividend shows, of course, an improvement. We begin to hope that the day is not very far distant when the ordinary shareholders will reap the reward of their patience. The Chatham and Dover Company makes progress in spite of its detractors.

All things considered, the Manchester, Sheffield, and Lincolnshire has done better than we anticipated. One per cent. is certainly preferable to ¾; and if the company is managed efficiently, further progress may be made by the end of the year.

The Metropolitan is moving on rapidly. In addition to the increase in the dividend £729 is carried forward. But a more satisfactory feature than that about the report is that the traffic receipts have increased £11,205 during the half year. If the directors will only see that their carriages are lighted properly—even if they go in for the new electric light—their earnings will be still further enhanced.

Concerning the Great Eastern, we regret that we are still unable to express ourselves hopefully. The report is even more unfavourable than we apprehended it would be. A decrease in the net revenue of over £8000 in the six months of 1877, as compared with a similar period in 1876, is not a healthy symptom, nor can it be explained in a satisfactory manner. Mr. Hadfield, the secretary of the Company, says in the official circular, that, "subject to final audit, the accounts for the past half-year show a sufficient sum for payment of all the preferences in full, carrying forward a small balance, subject to the amount of an exceptional expenditure of £36,000 for the renewal of permanent way being (if approved by the shareholders) carried to a suspense revenue account." We take it that the approval of the shareholders is a practical certainty, but the phrase is, nevertheless, a remarkable one. If the shareholders turned rusty, and declined to allow the £30,000 to be carried to a suspense revenue account—what then? We fear the Great Eastern directors are guilty of the miserable mistake of paying preferential dividend out of capital. It may now well be inquired upon what grounds they based their demands, when the negotiations with the Great Northern Company were pending. The future of the Great Eastern Company may depend upon the forthcoming election of directors. Nothing apparently can surpass the mismanagement there has been in the past.

ELECTRIFICATION OF PARTICLES FLOATING IN WATER.

IF coarsely pulverised Para nuts be shaken with ether, there appears a white powder which shows a distinctly crystalline structure under the microscope. The so-called crystalloid forms obtained thus have been subjected by M. Weyl to the action of electric currents under the microscope. For this purpose two triangular pieces of tin-foil were fixed in a glass plate with opposite points about two millimetres apart. Between them was put a drop of distilled water, in which the crystalloids were suspended. When the alternating currents of a sliding inductorium were sent through the drop the crystalloids, which before were quite irregularly distributed in the water, arranged themselves in perfectly regular

curves, which, garland-like connected the two tinfoil poles above and below; with a sufficient quantity of material, as many as six to eight such curves were often observed behind one another.

Once the arrangement was produced, the particles remained at rest in the places they took up, without any further action of the current being perceptible. The arrangement also continued after the current ceased to act. The crystalloids were always directed so that their longer axes lay in the direction of the curves.

The same behaviour was exhibited by various powders suspended in water, viz., copper-oxide, chrome-oxide, sulphide of iron, cinnabar, glass powder, fluoride of calcium, black Indian ink, carmine, coal, bubbles of oxygen and hydrogen, lycopodium (previously boiled, to prevent balling together), copper, platinum, zinc, and brass. The conductors of electricity among these substances presented a more complex phenomenon, for the metallic particles, with whirling motions, changed their places extremely quick, and at the same time little gas bubbles rose from their projections in the liquid. This development of gas, which was only observed from powders of metal, appears to arise from a decomposition of the water, and not from adherent air particles, else such an adherence would also have been observed in non-conducting powders. This gas-development makes the rotary movements of the metallic particles intelligible. Both phenomena are absent when the electricity acts only a short time; in this case the curves of metallic particles take the same form as those of non-conductors.

Thus the good conductors differ from the other bodies examined, inasmuch as they very soon change the position acquired through the alternating currents, in consequence of development of gas, due to a dielectric charge of the particles, and for the same reason a state of rest of the system, such as in the case of non-conductors and semi-conductors, does not occur.

To elucidate the cause of the phenomenon a series of modifications were introduced into the experiment. First, the conductive resistance of the distilled water in which the particles were suspended was diminished with ordinary salt or some sulphuric acid; the effect of this was that the phenomena of direction and arrangement were absent.

A constant battery current being allowed to act on the particles suspended in water, instead of the alternating currents of the induction apparatus, the long-known phenomenon of transference could be observed; the particles wandered (with a certain strength of current) towards the positive pole. A double movement of the particles was frequently perceptible. When the water was rendered conducting the transference phenomenon ceased.

When the constant current was, by means of a tooth wheel or other arrangement, frequently interrupted, so that intermittent battery currents, going in the same direction, acted on the suspended particles, these latter moved towards the positive pole, just as in the case of the uninterrupted battery current. The movement was a continual, not a jerking one when the number of interruptions was not too small. With exalted conductivity of the water, the phenomenon did not occur. It must, however, be remarked that the intensity of the currents available was not sufficient to carry forward large glass particles, and probably for this reason no direction of the particles was observable.

M. Weyl now made further experiments with the opening induction discharges of a small Ruhmkorff, whose closing induction currents were excluded. The first opening induction discharge always brought a particle observed under the microscope into a position parallel to the direction of the current. After several discharges nearly all the particles were brought into the parallel direction, with exception of the large particles, which were hindered by friction on the glass. Further opening discharges on the directed particles drove them towards the positive pole. In one case, when copper powder and quartz splinters floated in the water, the direction of the particles was at first produced quite as usual, but, on making further opening discharges, the copper particles wandered towards the positive pole, the quartz particles towards the negative. If 20 to 30 opening discharges were made in close succession, the particles stood with their long axes in the direction of the current, arranged in curve, as in the first experiments. Each further opening discharge approximated the particles to the positive pole. On addition of common salt or sulphuric acid all these phenomena disappeared.

Lastly, when alternating currents from a constant battery were caused to act on glass powder, coal, Indian ink, or carmine, distributed in water, each particle kept the same place which it had before the action of the current, during its action, and the particles were arranged in the usual regular curves their longer axes lay in the direction of the curves. These experiments prove that the action of the induction alternating currents and the alternating currents of a constant battery are the same; but they especially show that the state of rest of the curve system may be regarded as a function of the alternating currents.

The phenomena here described, of direction and still state of the particles, M. Weyl explains by the supposition, according to Faraday's view, that each particle reached by the current (conductor, half-conductor, non-conductor) becomes dipollarly electrical thereby. The separated electricities accumulate in each particle with predominant longitudinal direction at the two poles, and in consequence of the alternation of the two tinfoil poles, the charged particles must take direction. Each individual particle must attract the other, and so there arises a chain of particles whose oppositely charged poles are turned to each other.

"All this," says M. Weyl, "holds good for the case in which a single current impulse of short duration has come upon the particles suspended in water. If now the direction of the short currents is altered every instant, the attraction and direction of the particles produced by the first current impulse will not experience any change through the second current impulse, which is oppositely directed to the first; this merely reverses the signs of the poles. And the particles do not any further change their place under influence of the second impulse, since they are already, through the first current impulse, in the place to which the attracting or repelling forces of the two neighbouring poles of opposite sign have brought them. All subsequent current impulses act in like manner."

The curves in which the particles arrange them-

selves M. Weyl regards as the current curves. The suspended particles show the distribution of the current, as do the glowing particles of the electrode in the electric egg.

It is thus conceivable how the phenomena described do not occur when the conductive resistance of the current is diminished, since the current can now go past the particles without charging them, the liquid affording a good derived circuit.

[These researches are described in the *Archiv. für Anatomie und Physiologie.*]

Reviews.

Etude du Telegraphe Automatique de Sir C. Wheatstone. By ALBERT LE TUAL.

THAT a full and complete description of the Automatic telegraph of Sir Charles Wheatstone, an English invention, should have been left for a foreigner to bring out, may seem to reflect but little credit upon the English telegraph world, but it is really a question whether such a work would be of value in this country, at least one containing such a minute description of the system as is given in the work of M. Tual.

It would be difficult to find a more complete and accurate description of any telegraphic instrument than the one before us. There seems to be no point in the construction and working of the instrument left unnoticed. The explanations are very clearly made, and are assisted by an atlas of very excellent diagrams, which show every part of the instrument in the clearest manner.

Amongst other descriptions we find one of the pneumatic puncher employed with the instrument. We do not recollect having seen any English work which explains this part of the apparatus.

We certainly think M. Tual has done good service in bringing out the work, and he deserves all praise for the thorough way in which he has dealt with the subject.

Guide to the Correction of Errors in Code Telegrams. (Published by the Eastern Telegraph Company, etc.)

THE object of this pamphlet is to enable the public to rectify some errors which may occur in messages, in consequence of many words being absolutely or nearly identical in their telegraphic signals.

The loss of a single signal, a dot or a dash, or bad spacing in signalling, will sometimes entirely change the word which it was intended to transmit, and these mistakes may sometimes either seriously mislead the merchant, or other man of business to whom a telegram is sent, or may cause delay from the difficulty in deciphering the meaning of the message.

The pamphlet, with the view to enable the public to correct many of these likely errors, gives a table showing what transformations letters may undergo through the causes mentioned, and also a long list of words with their possible substitutions.

We recommend all whose business necessitates the constant receipt of telegrams to purchase this work, as it may save them much trouble and annoyance, and will repay them the shilling expended in its purchase many times over.

Correspondence.

[We do not hold ourselves responsible for any opinions expressed by our correspondents.—ED. TELEGRAPHIC JOURNAL.]

To the Editor of THE TELEGRAPHIC JOURNAL.

SIR,—I observe in your number of the 1st June last, an observation relative to a pamphlet which I have published upon electro-magnets.

I must remark with reference to this subject—

First, that I had sent this pamphlet at the end of July 1876 to the "Society of Telegraph Engineers," and that I received an acknowledgment of its receipt in the month of September. I was informed that a notice of my work would be inserted in a paper which Mr. Preece was preparing on "Shunts."

Second, my work has been read at the Société Scientifique et Industrielle, of Marseilles, at its meeting of October 12th, and was inserted in its proceedings for the year 1876, page 191. Consequently, it was before the lecture of the 14th February, 1877, that I published my investigations. Not having received the proceedings of this meeting of the 14th February, I do not know if Mr. Preece made mention of it. However, I trust he did, after the notice which had been given of it.

Allow me, Sir, to send you a copy of my work completed by a second note, which has also been inserted in the proceedings of the Société of Marseilles.

Accept, Sir, the assurance, &c.,

EMILE LACOINE,
Electrician.

Administration of Telegraphs,
Constantinople.

To the Editor of THE TELEGRAPHIC JOURNAL.

SIR,—Can you or any of your readers kindly give me a reference to an account of Edison's Speaking Telegraph? I am, yours truly,

ALPHA.

[We hope to give a short description in our next.—ED. TELEGRAPHIC JOURNAL.]

To Correspondents.

*** Duly authenticated contributions, theoretical and practical, on every subject identified with the interests of which THE TELEGRAPHIC JOURNAL is the organ, will always command attention. Anonymous correspondence will be wholly disregarded. Literary communications and books for review should be addressed to the EDITOR; business communications to the MANAGER, 10, Paternoster Row, E.C.

WE are requested to state that the offices of Greville's Australian Telegram Company are removed from No. 9A to No. 4, New Broad Street, E.C.

PROF. A. GRAHAM BELL'S telephone is being introduced in New England on short private lines, it is understood, with considerable success. The Professor, we also learn from the *Journal of the Telegraph*, is soon to be married to a daughter of Mr. Gardner G. Hubbard, of Boston, Massachusetts. The bridal couple will leave for Europe.